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Introducing the new Water Efficiency Labelling and Standards (WELS) Scheme

Shane McWhinney, Acting Director, Environment Standards Branch, Department of the Environment and Heritage

Because of the importance and imminent introduction of the new WELS scheme to water supply demand management activities across the country, WSAA invited Mr McWinney to prepare a paper on details of the scheme.

WSAA will be working closely with the Commonwealth to facilitate a smooth implementation and enhancement of the scheme.

What is the WELS scheme?

Australia is the driest inhabited continent in the world, and yet Australians are amongst the highest water users in the world. As part of the solution, the Australian Government in conjunction with the State and Territory Governments has developed the Water Efficiency Labelling and Standards (WELS) Scheme to introduce mandatory labelling and standards requirements for a range of common water-using products. The first of its kind in the world, this national scheme will help us all to conserve water – an increasingly precious resource - by promoting water efficient products. The need to reduce our consumption of water across urban Australia will only grow as populations increase and climate change results in more frequent extreme dry weather conditions.

The WELS scheme builds upon and supersedes the voluntary National Water Conservation Rating and Labelling scheme administered by the Water Services Association of Australia since 1995. This voluntary scheme covered shower heads, dishwashers, clothes-washing machines, urinals, taps, toilet suites and flow regulators.

Under this early scheme, manufacturers, importers or distributors could apply for a licence after having their product independently tested by a recognised laboratory to determine the appropriate rating. However, because this scheme was voluntary, naturally only manufacturers with the most water efficient products chose to have their products rated and inefficient products were therefore unlabelled.

The limited coverage of the voluntary scheme also undermined the consumer recognition of the voluntary labelling scheme.

Initially the WELS scheme will cover washing machines, dishwashers, showers, toilets, urinals and certain types of taps. Flow control devices for taps will also be covered on a voluntary basis, and the scheme may extend to other products in the future.

It is projected that, by 2021, the scheme will cut domestic water use by 87 200 megalitres per year (or five per cent), totalling a water saving of 610 000

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megalitres – more water than in Sydney Harbour. Over the same period the community stands to save more than $600 million through reduced water and electricity bills, and the amount of energy saved each year will be the equivalent of taking around 150 000 cars off Australia's roads.

A Regulation Impact Statement conducted by the Australian Government's Department of the Environment and Heritage for the WELS scheme found that toilets should, in additional to labelling, be subject to an immediate mandatory minimum water efficiency standard. A minimum standard is already effectively in place for toilets, with 6/3 litre dual flush toilets mandatory in new work in most parts of Australia. The WELS scheme will reinforce this.

The labelling aspect of the scheme may also lead to the development of minimum water efficiency standards for other products by providing information on the efficiency of different types of products, their market penetration, and how manufacturers and importers would be affected by any minimum standard.

How is the WELS Scheme being implemented?

Commonwealth legislation to implement the WELS scheme, called the *Water Efficiency Labelling and Standards Act 2005* (WELS Act), was passed in February 2005.

Under the WELS Act, the Minister for the Environment and Heritage has the power to determine the products to come under the Scheme and the standards that will apply to them. The first ministerial determination is expected by the middle of 2005 and will make mandatory the relevant Australian and New Zealand Standards, which will set out the criteria for the rating and labelling of products and will also specify the minimum water efficiency and general performance requirements. The main standard for the WELS Scheme will be the republished standard *AS/NZS 6400:2005 Water-efficient products—Rating and labelling*. All products that come under the WELS Scheme will need to be registered as set out in the standard, and a public register of WELS products and their ratings will be available via a website.

The WELS Act regulates any "supply" of a product, where supply means "supply for consideration" or "offer to supply for consideration". In other words it doesn't matter where you are in the supply chain you need to make sure that the products being supplied comply with the WELS Scheme's requirements. The WELS Scheme is not just a "point of sale" scheme – it captures manufacturers, importers, wholesalers and retailers alike. Sensibly however, the WELS Scheme's requirements will not apply to second hand products unless they are imported second hand for supply in Australia.

The WELS Act contains a range of criminal offences and establishes a national Regulator to monitor and enforce compliance with the WELS scheme. The offences are generally set at 60 penalty units for an individual (currently $6,600) and may be up to five times that amount for a body corporate. The offences include:

- Supplying unregistered products;
- Supplying unlabelled products;
- Supplying products that do not comply with minimum efficiency or general performance requirements;
- Misusing WELS standards or providing information that is inconsistent with WELS standards.

The WELS Act also includes offences for failing to comply with certain requests from WELS inspectors, with the penalty being "Imprisonment for 6 months"!

State and Territory Governments are also in various stages of passing "mirror" legislation that complements the Commonwealth legislation. Essentially the State and Territory legislation fills in the "gaps" in the Commonwealth's powers to ensure a comprehensive legislative framework exists.

How will the scheme operate and be regulated?

The WELS Scheme will require certain products to be registered with the WELS Regulator by providing all the relevant details about the manufacturer and the product, including the product's test reports against the relevant standards and any other related product certifications.

After the Regulator accepts the registration details, they will register the product and approve the use of the appropriate water efficiency rating label for a period of five years. Registration can however be suspended or cancelled in a variety of circumstances.

The Regulator will appoint inspectors to monitor and enforce compliance with the registration and labelling requirements through activities such as:

- Conducting retail surveillance to ensure all products are correctly labelled;
- Undertaking independent evaluation of products or "check testing" to ensure that products do indeed perform as per the registered information;
- Investigating complaints or concerns raised by manufacturers or consumers about particular products;
- Conducting detailed investigations where a serious breach of the requirements is suspected.

What will it mean for consumers?

Specifiers and consumers will, for the first time, have access to credible and independently verified information about the water efficiency of all products that come under the WELS Scheme. In contrast to voluntary labelling, where only a small selection of products will ever participate in the program, with mandatory labelling products will not be able to "opt out" of the scheme. Hence a person will always have access to information about the water efficiency of a product in a form that's easy to understand.

The WELS Scheme
Continued

What products will be covered?

Initially the WELS Scheme will cover washing machines, dishwashers, showers, toilets, urinals and certain types of taps. Flow control devices intended for use with taps will also be covered on a voluntary basis. Choosing a water efficient product can make a real difference. For instance:

- The most efficient dishwashers use half the water of old or inefficient dishwashers
- Taps with an aerator or flow restrictor use half the water of standard taps
- A water efficient washing machine uses one-third the water of a water guzzler
- An eight-minute shower using a regular showerhead uses around 120 litres of water. A water efficient showerhead uses less than 72 litres – 40 per cent less water.

What will it extend to in the future?

In addition to the seven initial products, the WELS Scheme may extend to other products in the future such as evaporative air coolers, the various types of hot water systems (storage, instantaneous, solar, etc), and waterless urinals. The Department of the Environment and Heritage will continually review the case for the inclusion of new products and assist in relevant research and assessment.

When will the WELS scheme start?

The WELS Scheme should be fully operational by the middle of 2005 when all products will be able to be registered and labelled. Industry will however be given one year's notice of the regulatory requirements before registration and labelling will be compulsory by the middle of 2006.

What will the label look like?

Most consumers recognise the yellow and red stars indicating energy efficiency of electrical products, so the new WELS label is similar to the existing energy label to leverage as much consumer recognition as possible. Indeed, most consumers are so familiar with the energy label that when they are shown the proposed new WELS label they believe they have seen it before on plumbing products!

Sample clothes washer label

What do the stars really mean?

Products will be rated out of 6 stars. For each product, the number of stars on a label will mean something different. For example, a 5 star dishwasher (with 12 place settings) will only use 10 litres of water on a standard cycle, whereas a 1 star dishwasher will use about 21 litres of water.

A 3 star shower or tap will use around 9 litres per minute, whereas a 1 star shower will use around 14 litres per minute.

A 4 star toilet will use around 3.5 litres per average flush, whereas a 1 star toilet will use around 5.5 litres per average flush. Just in case you're wondering, the "average flush" for a toilet is the average of 1 full flush and 4 half-flushes! As an example, the new "Caroma Smartflush" toilets use only 4.5 litres for a full flush and 3 litres for a half, so that the average flush ends up being only 3.3 litres, which is a 4 star toilet!

More information?

The WELS Scheme's permanent website will be up and running in late June 2005 at:

www.waterrating.gov.au

The WELS Scheme website will provide information on and links to:

- The *Water Efficiency Labelling and Standards Act 2005*;
- The *Water Efficiency Labelling and Standards Regulations 2005*;
- The *Water Efficiency Labelling and Standards Determination 2005*, which contains the relevant technical standard;
- Corresponding State and Territory legislation;
- How to register and the fees payable;
- Products registered under the WELS Scheme;
- Guidance for consumers and industry;
- Other sites of interest.

Further information may also obtained by calling the Department of the Environment and Heritage on Freecall 1800 803 772.

What else are governments doing to conserve urban water?

The Australian Government is also working in partnership with the State and Territory Governments to develop *National Guidelines for Water Recycling – managing health and environmental risks*. The national guidelines will be an Australian first aimed at increasing the water recycling opportunities to provide new alternative sources of supply in a way that protects public health and the environment. The guidelines will cover water recycling and water sensitive urban design. They will enable recycled water to be used for garden watering, car washing, toilet flushing, clothes washing, agriculture, fire fighting systems and certain industrial uses. The guidelines are expected to be completed in 2005.

Performance of above ground MSCL water supply pipelines in a bushfire

David Ellis, Materials Sciences Officer, Engineering and Projects Division, South Australian Water Corporation

On Tuesday January 11th an out of control bushfire devastated the Lower Eyre Peninsula farming community in South Australia. It was reported the fast moving fire which destroyed over 70 houses, several thousand sheep and hundreds of kilometres of fencing reached temperatures of 1000ºC at the fire front. Lower Eyre Peninsula in South Australia is supplied with bore water taken from three bore fields. This water is also supplied to Upper Eyre Peninsula via the Tod Trunk Main. Five above ground rigid steel pipelines from 300 to 425 millimetres diameter which were constructed between the early **1940s** and **1950s** were located in the fire area. The 825 millimetre diameter Tod pipeline was constructed in the **1960s**. Approximately 60 kilometres of pipeline was located in the fire area.

The fire caused extensive damage to the pipelines which resulted in several breaks and loss of water. Seventy seven circumferential welds were repaired, 13 lengths of pipe were replaced and numerous water meters were replaced during the emergency repairs which were completed six days after the fire. Welders and repair crews were brought in from Adelaide and other regions in the state with most having to drive 700 to 800 kilometres to the fire area. Water was restored gradually as repairs progressed with all customers receiving water after six days.

A detailed condition assessment of the six above ground MSCL pipelines was conducted following the fire.

Expansion beyond design limits resulted in the pipe lifting off of the supports, bending and breaking at a welded joint

Pipes

The pipelines are designed for maximum temperatures of 55ºC. High temperatures caused the pipeline to expand beyond its design limits and this resulted in breaks at welded joints, bending of the pipeline, bulges in the pipe wall and lifting of the pipe from the pipe support chairs. It is of interest to note that a 20ºC rise in temperature results in expansion of 250 millimetres each kilometre.

120 metres of pipeline was replaced at three locations during emergency repairs and a further 90 metres will be replaced during the coming winter. Breaks at welded joints were repaired by rewelding of the joints or installation of repair collars where significant damage occurred to the pipe ends.

Three pipe lengths were replaced adjacent to a caravan park where intense heat from burning caravans resulted in excessive sagging and bending of the pipeline. Intense heat adjacent to large trees along the Lincoln Highway resulted in bulging and bending of the pipe and the inorganic zinc silicate protective coating burnt off

Performance of above ground MSCL water supply pipelines in a bushfire
Continued

Excessive expansion caused the pipe to concertina and fail at a welded joint

Cracked and spalled concrete thrust block

Concrete thrust block split on each side of hold down bolt

at two locations where replacement pipes are now required. Further along the highway fifty six metres of the main is misaligned and pipe replacement is also required. In a straight section of pipeline a severe bend occurred in the centre of a pipe length which was subsequently replaced. Severe damage also occurred to a section of pipeline where intense heat resulted from a very high fuel load. Eight lengths of pipe were replaced and a further 20 metres is listed for replacement.

When emergency repairs were made the pipelines were not joined at the designed link in temperature range between 12ºC and 20ºC and this has already resulted in two circumferential welded joint failures during the night when temperatures decrease. Further breaks are expected during the coming winter and damage to new and existing thrust blocks is also possible when the pipes contract further.

Concrete Pipe Supports

The most significant damage occurred to concrete thrust blocks which are designed to resist transverse forces. No thrust blocks were directly damaged by the fire, although many were cracked and spalled as a result of excessive expansion of the pipeline, particularly near pipeline breaks. At these locations the high temperatures from the fire caused the pipeline support loads to exceed their design limits.

Thrust blocks with concrete cast around the full pipe circumference were used at horizontal bends. Many developed horizontal cracks and minor spalling adjacent to the pipe. Some had severe cracking and spalling as a result of excessive pipe expansion and steel reinforcement was exposed. These required replacement.

Thrust blocks used primarily along straight sections of pipeline at 80 metre intervals to restrict vertical movement had cast in anchor bolts with angle brackets welded to the pipeline. This is the type of thrust block used on our pipelines since the 1960s. Many cracked, split and spalled as a result of excessive temperature related longitudinal movement, primarily in areas each side of pipe breaks. Anchor bolts were bent, some bolts sheared off at the pipe brackets, pipe anchor brackets were bent, welds sheared off and broke and some anchor bolt nuts pulled off where the full length of thread was not engaged. Many blocks tilted and some were lifted out of the ground. Some blocks and brackets were repairable, however a number of blocks split through the centre at the anchor bolt and required replacement.

Performance of above ground MSCL water supply pipelines in a bushfire
Continued

Spalled concrete thrust block with failed anchor bolt

Pipe support chairs are generally located near each pipe joint and support the weight of the pipeline. As these are not fixed to the pipeline the main damage resulted from excessive pipe expansion which caused tilting of the chairs and spalling of concrete. Misalignment of the pipelines and excessive movement also resulted in the pipeline being supported on one half of a chair or lifting right off and having no support. Excessive heat at some locations affected the concrete which was overheated and resulted in concrete which was weak and crumbling. Replacement or repair of many pipe support chairs is required, but as they have lower priority than the thrust blocks it may be sometime before they are replaced.

Protective Coatings

Above Ground Pipes

A 4 kilometre section of pipeline North of Tod Reservoir was coated with red lead based metal primer and aluminium pigmented topcoat. These coatings typically tolerate temperatures in the range 90 to 120ºC before they suffer damage. This pipeline experienced some minor coating damage where local areas of blistering of the aluminium top coat were noted. The total area affected was less than two square metres. Fortunately an access track followed along one side of the pipeline and the other side had been cleared of trees. This eliminated high heat loads adjacent to the pipeline and prevented any significant damage.

All other pipelines were coated with inorganic zinc silicate which included factory applied heat cured products such as Dimetcote 2 and field applied water borne and solvent borne coatings. Typically these products tolerate constant temperature of 400ºC and short term rises up to 540ºC. Virtually no damage resulted to the inorganic zinc silicate coatings, although much of the length of the pipeline was covered with deposits of soot. These superficial deposits were readily removed to reveal the unaffected coating beneath and will have no long term affect on the coating life. Damage to the inorganic zinc silicate coating was noted at few locations. The coating had burnt off exposing bare steel and the high temperatures associated with this had caused the pipeline to deform and bulge the pipe wall. Some small isolated locations on field applied recoated sections had experienced blistering of the top coat, however these locations are most likely related to areas of inadequate surface preparation.

Below ground Road Crossings

Most were concrete encased and were largely unaffected by the fire although cracks caused by the fire was evident at a few locations. One road crossing had been replaced and the pipe was coated with Sintakote (fusion bonded polyethylene). No melting or damage occurred to the exposed Sintakote above ground, but it was covered in a layer of soot from the surrounding burnt grass.

Some below ground sections were coated with petrolatum wrapping tapes. Above ground some PVC overwrap tape had burnt and the underlying petrolatum tape had softened and melted at some locations. Generally it suffered only superficial damage and sufficient remained to provide adequate continued protection.

Many below ground sections were coated with field applied coal tar enamel. Damage was noted above ground where the coating softened or melted and in some instances it was burnt. Severe damage was noted on exposed pipe sections of the newer Tod Trunk main that was coated with factory applied coal tar enamel wrap, which contains a woven asbestos reinforcement. Severe damage on the lower half of the pipe resulted in melting and burning of the coal tar enamel. This resulted in loose friable asbestos wrap hanging on the pipe and lying on the ground adjacent to the pipe. Licensed contractors were engaged to remove the friable asbestos.

Performance of above ground MSCL water supply pipelines in a bushfire
Continued

Internal Cement Mortar Lining

Several pipes were replaced as a result of damage from the fire. These pipes which had experienced very high temperatures were inspected as they provided an indication of the likely lining condition in all pipes in the system. The lining thickness varied from 12 to 15 millimetres and testing indicated no increased loss of alkalinity resulted from the fire. The lining retained its adhesion to the steel surface where the pipe wall had not deformed. Small blisters were noted on the surface of the cement lining and it was concluded that these resulted from steam escaping from the water saturated lining.

The evaluation revealed the internal lining was in good condition where deformation of the steel had not occurred and that minimal deterioration had resulted from the fire. Damage to the lining also occurred in the vicinity of many repair collars which were installed at a number of locations along the pipeline. It was therefore concluded that the lining in all above ground pipelines in the fire area (except sections indicated for replacement) remain in sound serviceable condition.

Steel repair band welded around failed joint. Pipe supported on temporary timber blocks as concrete supports were damaged

Summary and Conclusions

- Emergency pipeline repairs which restored full water supply in six days were temporary with further work being required in the longer term. It was estimated that more than 90% of the pipeline in the fire area experienced no significant damage. Significant repairs including replacement of pipes, pipe realignment, replacement of support chairs and replacement or repair of thrust blocks was required to 5% of the pipeline.
- Most pipe damage occurred in the vicinity of high fuel loads adjacent to the pipelines where high temperatures caused the pipeline to expand beyond its design limits. Sustained high temperatures caused by man made materials, large trees and thick undergrowth resulted in the most severe damage. At locations of low fuel such as grass and small bushes no damage occurred to the pipelines. A two to three metre wide strip should be cleared of trees and thick undergrowth on each side of the pipeline to reduce the high fuel load and greatly reduce the risk of fire damage.
- No significant damage occurred to external protective coating. The inorganic zinc silicate protective coating was an excellent choice for above ground pipelines which have the potential to be affected by bushfires as it is usually unaffected by fires. The pipeline with a red led primer and aluminium top coat suffered minimal damage as trees had been cleared along both sides of the pipeline.
- Large diameter pipelines have a lower likelihood of damage as the volume of water and pipe materials require more heat energy than a smaller pipe to increase the pipe temperature by the same amount. No breaks occurred in the larger 825 millimetre diameter Tod main.

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WSAA's Occasional Papers

From time to time WSAA publishes the results of significant research projects affecting the urban water industry.
The three most recent projects which are summarised in this article have been initiated and funded by WSAA at the request of Members.
The full printed papers are available from the WSAA online bookshop at info@wsaa.asn.au.

Health Risk Assessment of Fire Fighting from Recycled Water Mains

Occasional Paper No. 11 - November 2004

Research by: Water Futures Pty Ltd 32 Sirius St, Dundas Valley, NSW 2117

Authors: Dr Daniel Deere and Dr Annette Davison of Water Futures Pty Ltd
in conjunction with
Dr. David Cunliffe Department of Human Services, South Australia
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Mr Peter Donlon Water Services Association of Australia

This paper reviews national and international information on the health risks to fire fighters associated with the use of various qualities of recycled water

The Problem leading to the Study

Dual water supply systems using recycled water in one main are increasing in prevalence in Australia. A key sizing criterion for these mains is the provision of fire services.

To achieve optimum use of this pipeline infrastructure, it is important to be able to use the recycled water main for fire fighting service provision while protecting the health of fire service personnel.

WSAA therefore commissioned this study to better define health risks to fire fighting personnel from the use of recycled water.

Key Messages from the Study

- Specific and explicit health guidance exists endorsing the use of high quality Australian Class A recycled water for fire fighting.
- High quality recycled water is as safe as, or safer than, many alternative water sources used for fire fighting.
- Epidemiological evidence from exposure to sewage (treated and untreated) indicates that high quality recycled water would not lead to observable effects when used for fire fighting.
- Quantitative risk assessment techniques indicate that health risks to fire fighters from high quality recycled water is below WHO reference risk levels.

These results indicated high quality recycled water used in urban environments is safe for fire fighting.

Research Methodology

- The research plan examined the following issues:
- A literature review was carried out comprehensively examining Australian and International recycled water guidance documents. WSAA also contacted key international researchers and agencies in the recycled water area.
- Reviews of the hazards found in untreated recycled water and their removal were undertaken. These included enteric microbial pathogens, opportunistic pathogens and chemicals.
- The quality of recycled water was compared to other alternative waters used for fire fighting purposes, including urban streams, swimming pool water and drinking water.

Health Risk Assessment of Fire Fighting from Recycled Water Mains
Continued

- Recycled water was compared with information from epidemiological studies on health effects from irrigation, recreational waters exposure and occupational exposure to sewage.
- The risk methodology proposed to be used in the new National Recycling Guidelines was applied to fire fighting. Exposure assessment was carried out using information from the NSW Fire Brigade. Tolerable risk levels and reference pathogen information was used according to the 2004 WHO International Guidelines for Drinking Water.

Research Findings

National and International Guidance

Guidance approving recycled water for fire fighting is provided in:

- The NSW Guidelines for Urban and Residential Use of Recycled Water (1993).
- The Draft Qld Recycled Water Guidelines (2004).
- The South Australian Guidelines for Recycled Water (1999)
- The Tasmanian Guidelines for Recycled Water (2002)

Examples of international guidance include the widely referenced California requirements which allow for fire fighting for urban recycled water which meets the Californian Code. This requires filtered, disinfected tertiary treated recycled water which meets turbidity limits (2 NTU) defined under the code.

Hazards found in Recycled Water

The principal hazards identified in untreated recycled water were microbial in nature, principally the enteric:

- Bacteria (eg salmonella, pathogenic E. *coli*)
- Viruses (eg rotavirus and hepatitis virus)
- Parasites (eg cryptosporidium and giardia)

Opportunistic pathogens such as Legionella and Pseudomonas were also identified as possible risks as well as microbial endotoxins (bacterial cell wall remains).

Chemical agents were identified as being of less risk due to dilution factors.

Significant information is available showing that treatment systems are effective in removing the risk from microbial pathogens including opportunistic pathogens.

Risks from endotoxins are low to negligible with a multiple treatment train such as would be used for high quality recycled water.

Recycled Sewage Compared to Other Waters for Fire Fighting

Compared to health risks associated with many other sources of water used for fire fighting, the periodic health risks to fire fighters using high quality recycled water to fight a fire would be approximately equivalent to or less than:

- Periodic risks to fire fighters using most alternative sources such as swimming pools and urban surface water
- Annual risks to consumers of high quality drinking supplies and
- Periodic risks to consumers and fire fighters of using poorer quality potable drinking supplies.

Epidemiological Risk Assessment

In studies where workers were exposed to high quality recycled water used at agricultural sites no ill effects were apparent. This exposure would be expected similar to fire fighters.

Epidemiological studies with primary contact recreational waters show no ill effects with poorer water quality than are present with high quality recycled water.

Occupational health studies with workers exposed to raw sewage show some studies reporting relatively mild health effects. With the much high quality recycled water used in urban systems, health effects for fire fighting exposure would therefore not be expected.

Quantitative Microbial Risk Assessment

Research over the past decade has better defined the risk of disease in relation to the levels of pathogens present, exposure to these pathogens and the host response to such exposures. This methodology (Quantitative Risk Assessment) has been outlined in the 2004 World Health Organisation (WHO) International Guidelines for Drinking Water. WHO have also identified tolerable risk levels (one micro DALY).

Based on the WHO risk methodology and levels of tolerable risk, reference pathogen modelling (for rotavirus, hepatitis virus, cryptosporidium and enteropathogenic E.*coli)*, with exposures estimated by the NSW Fire Brigade, risk levels where shown to be below the WHO target risk level or one micro DALY and therefore acceptable.

WSAA's Occasional Papers
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Pricing for Recycled Water

Occasional Paper No. 12 - February 2005

Research: **ACIL Tasman Pty Ltd**
In association with: **GHD Pty Ltd**

Principal Authors: **Michael Woolston** and **Sue Jaffer** of ACIL Tasman Pty Ltd

The Occasional Paper develops guidelines for the pricing of recycled water in the context of the existing suite of products and services provided by the urban water industry

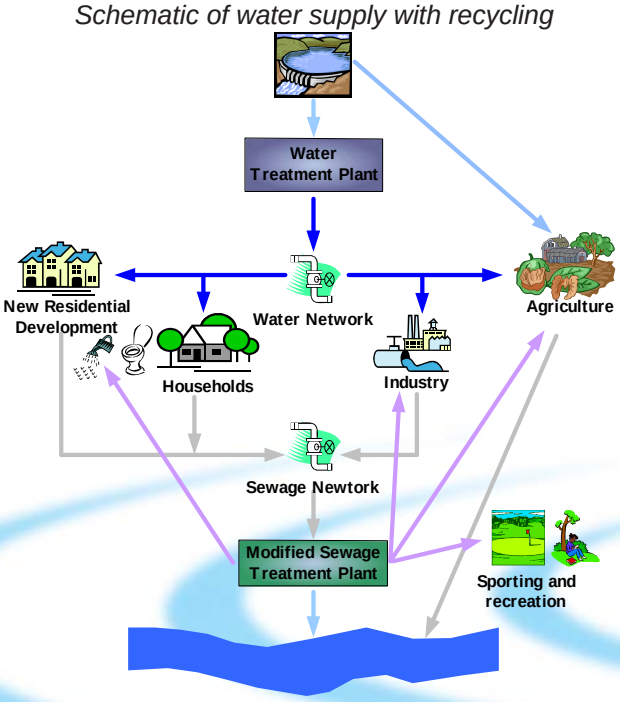
The Problem leading to the study

Sustainability, security of water supply, demand management are increasingly crucial issues for the urban water industry. Water recycling is a key component of a strategy to address these issues.

In recent years the urban water industry has addressed the technical challenges of using different types of recycled water in a range of applications and managing the public health and environmental risks of this valuable resource.

This study develops pricing principles for providing recycled water in various circumstances.

Schematic of water supply with recycling



Key Messages from the study

- Prices should be set within a price band with incremental costs as the floor and willingness to pay as the ceiling.
- Commercial judgement should determine the price set within that band.
- Prices for recycled water should track the price of substitutes.
- Prices for recycled water are an integral part of the pricing structure of the suite of products and services provided by the utility.
- In the event of mandated recycling targets, any required subsidies for recycled water should be at the expense of the broader customer base and fully and transparently costed (preferably by way of a community service obligation, (CSO)).
- Mandated uneconomic recycled water projects without CSO funding should have their associated costs recognised by a regulator as a cost of doing business to be recovered from other customers.
- While regulators have a legitimate role in prices oversight, regulation of prices of recycled water should be light-handed to provide the requisite flexibility.
- Efficient pricing of recycled water may lead to different prices for different customers.

Pricing for Recycled Water
Continued

Research Methodology

Pricing principles for recycled water were developed recognising that there are various types of recycled water and that it is one of a suite of products and services provided by the urban water industry. In addition to the pricing principles, methodologies for setting prices within an efficient band were developed. The practical application of these pricing principles was illustrated through three case studies:

1. high quality recycled water for industrial processes,
2. recycled water to horticulture, and
3. recycled water for a new housing development.

Research Findings

Recycled water is part of a suite of products/services

Pricing for recycled cannot be sensibly addressed in isolation but should be assessed within the context of other services provided by the industry. This is because the provision of recycled water can delay or negate the need for new water augmentation or wastewater treatment with benefits for the broader customer base.

The efficient pricing band

The price of recycled water should be determined between an efficient pricing band with incremental costs as the floor and willingness to pay or stand alone costs as the ceiling. It is important not to lock in artificially low recycled water prices for long periods. In negotiating a price within the efficient price band, it is also crucial to consider the price of alternative products.

These considerations may result in different customers facing different prices for recycled water. While regulators have a legitimate interest in overseeing prices charged for recycled water, the nature of determining prices for recycled is such that regulators should require the application of specified principles rather than prescribing actual prices or directly intervening in commercial negotiations between a water utility and end users.

Do not distort price signals

It is often argued that the price of recycled water should be deliberately set below the costs of providing the product. The argument often put forward to justify this position is a perception that price of potable water itself does not include costs such as the environmental damage of freshwater abstraction and that the provision of irrigation water is subsidised. The best response to any distortions in the pricing of either potable or irrigation water is to remove the original distortions rather than introduce other distortions in the market for recycled water. Suppression of prices for potable, irrigation and recycled water will only encourage excess water consumption and send perverse signals to users of water and to those who could provide additional investment in alternative water supply provision and demand management options. These outcomes are inconsistent with the key objective of a more sustainable water resource management.

WSAA's Occasional Papers
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Chlorination of Saxitoxins

Occasional Paper No. 13 - March 2005

Research by Cooperative Research Centre
for Water Quality and Treatment Private Mail Bag 3,Salisbury, South Australia

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This paper describes research carried out on the inactivation of algal toxins (saxitoxin group) by chlorination at levels achievable in water treatment facilities

The Problem leading to the study

Saxitoxins (also known as paralytic shellfish poisons) are a group of toxins produced by the commonly found cyanobacterium, *Anabaena circinalis*. The widespread occurrence of these toxins makes them a very important class of cyanobacterial toxins to the Australian water industry.

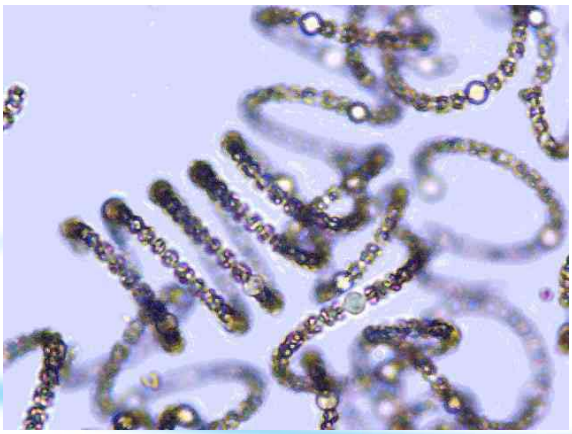
Chlorination is a widely used as a disinfectant practice in many Australian cities. Since chlorination is known to inactivate other cyanobacterial toxins (eg microcystins), this research aimed to determine the likely effects of chlorine on saxitoxins.

Key Messages from the study

The research showed the following:

- chlorination, at levels practiced by water utilities, can inactivate individual saxitoxins,
- the ease of inactivation of each saxitoxin was in the following order (STX > GTX3 ~ C2 > C1 > GTX2),
- removal was very pH dependant with 90% removal possible at pH 9 with 0.5mg/L free residual for 30 minutes contact time, and
- at typical pH's used in water treatment plants (pH 7) only 50% of the toxin is removed.

Anabaena circinalis – the toxic Cyanobacterium that produces Saxitoxins (paralytic shell fish poisons)



Chlorination of Saxitoxins
Continued

Research Methodology

The research was carried out in three stages over a period of four years at both NRCET in Queensland and at the AWQC in Adelaide. Scum material was collected during a highly toxic bloom of *A. circinalis* in Coolmunda Dam, Warwick, Queensland in 1997 and kept frozen as a source of the saxitoxins.

The toxins were purified and concentrated by first extracting using freeze/thawing and sonication, followed by protein precipitation, then pigment removal and cleanup using column chromatography.

Water samples from Hope Valley Reservoir in Adelaide and North Pine Dam in Queensland were spiked with the toxin at a range of pH's.

Chlorine was applied to the samples, initially at high doses (20mg/L) to overcome high chlorine demand and then in the stage 3 experiments with more purified samples at more typical water treatment dose levels (2mg/L).

Following quenching of the toxin-chlorine reaction at specific times, residual toxin was analysed using high pressure liquid chromatography with fluorescence detection.

Research Findings

The research found that saxitoxins in water can be removed to varying degrees by chlorination. The effectiveness of the removal was very pH dependant with high removal rates being achieved at pH 9.0 with residual chlorine of 0.5mg/L for 30 minutes contact.

Removal does not appear to be affected by residual chlorine levels as residuals higher than 0.5 mg/L did not lead to substantially more inactivation. Removal was not linear with the degree of removal increasing rapidly at around pH 7.5.

The form of the chlorinating agent (gaseous chlorine or hypochlorite) had no effect on toxin inactivation when pH was taken into account.

The more effective removal at high pH was unexpected as chlorine is known to be a weaker oxidant at high concentrations. This is attributed to the toxin molecules being present in an unprotonated form at higher pH and therefore more susceptible to oxidation.

The saxitoxin group of toxins consist of a number of similar chemical compounds, each with a lesser toxicity than the reference saxitoxin (STX) compound. Total toxin inactivation was described by summation of total saxitoxin equivalents – a means to describe total toxicity and its inactivation.

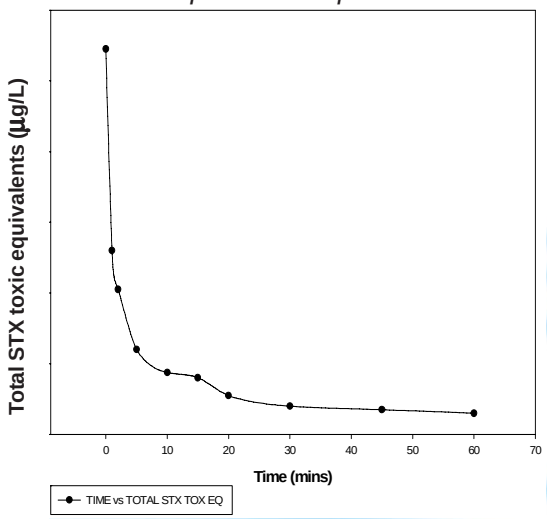
The differing individual saxitoxins had different inactivation rates, dependant on pH. The order of the ease of inactivation was STX > GTX3 ~ C2 > C1 > GTX2. 95% of STX was removed at pH 7.5, however pH 9.0 was required for the other more resistant saxtoxins.

The degradation of over time and pH could be described by second order kinetics and depended on concentration. The greatest inactivation occurred immediately after chlorine dosing.

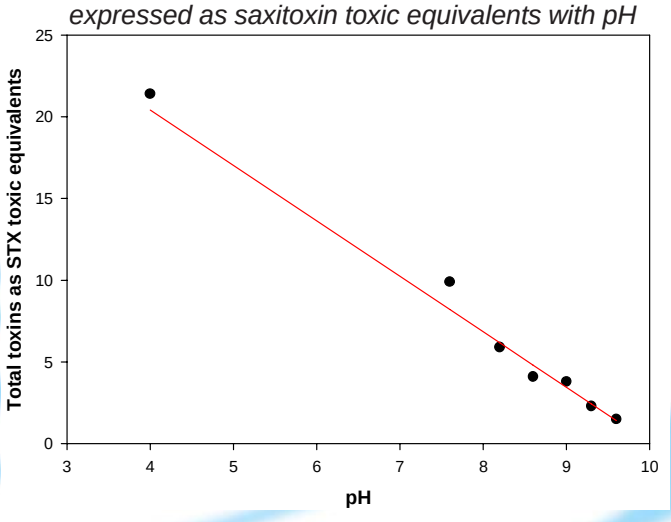
Inactivation products were non toxic as assessed by mouse bioassay.

The research shows that it is practical to inactivate the majority of saxitoxins by relatively minimal modification to normal water treatment disinfection and pH control practices. However in systems prone to saxitoxin presence, activated carbon should also be incorporated in the treatment chains as part of the multiple barrier approach to ensuring safety for drinking water supplies.

Degradation of toxins expressed as total STX toxic equivalents at pH 9.0



Destruction of total saxitoxins in semipurified form expressed as saxitoxin toxic equivalents with pH



Hydraulically Flow Modulated Pressure Control - is this the way forward?

Ian Maggs Water Demand Management Engineer, Wide Bay Water Corporation

Summary

Pressure Management is becoming ever more important due to increasing demands on our supplies of fresh water. By decreasing pressures in water distribution systems, leakage can be minimised and burst rates lowered considerably. Pressure control can be classed as fixed ratio, fixed outlet or flow modulated. Flow modulated pressure reduction allows a greater reduction in pressures throughout the day whilst also ensuring that the critical points do not suffer from over reduction.

Electronically controlled flow modulation is the most flexible way of reducing pressures, but the introduction of well designed hydraulically flow modulated pressure reduction valves, gives a cheaper option whilst delivering some of the major benefits of flow modulation.

1. Introduction

1.1. Pressure Management – Why?

It is well known that pressure is a function of the rate of leakage within a water distribution system. It has also been shown that there is a strong relationship between burst rates and pressure levels. Further work is required but it is currently thought that burst frequency may be proportional to pressure cubed.

With pressure having such an important role to play in the operation of a water distribution system, it is important to control the delivered pressure so that not only is the pressure reduced to a minimum level to control leakage and burst rates, but also to deliver an adequate service to all customers. The pressure management team within any water organisation are seen as both the good guys, for their action to reduce losses and burst rates and the bad guys for reducing the customer's ability to strip paint from their neighbour's roof using a garden hose!!

How can a consistent level of service be maintained to a customer with an advantage gained from a lowering of pressure profiles throughout the day?

1.2. Pressure Management – How?

A Pressure Reduction Valves (PRV) is a mechanical device that causes a reduction in water pressure across the mechanism. This means that the outlet pressure into the distribution system is lower in comparison to the inlet pressure. PRVs come in a variety of shapes and sizes, from extremely simple devices to complex hydraulic and electronic forms of control. This paper seeks to explain the various forms of pressure reducing valve with the focus on an innovative design of valve, the C-valves Pressure and Flow Regulator (PFR), which has been recently introduced to the Australian market.

2. Pressure Management Methods

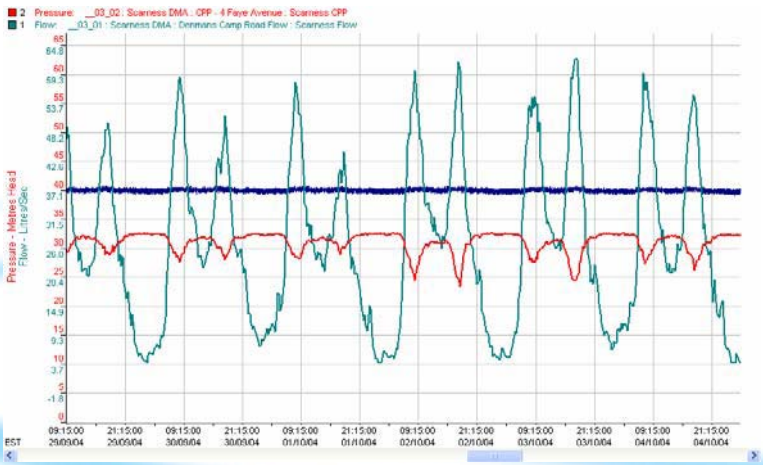
2.1. Basic Pressure control

Traditionally, pressure reducing valves are either fixed ratio or fixed outlet devices. Fixed ratio valves reduce the inlet pressure by a set amount to give a lower pressure at the outlet. For example a fixed ratio of 10 kPa would give an outlet pressure of 40 kPa for an inlet pressure of 50 kPa.

Fixed outlet devices are more complex than fixed ratio valves and involve a pilot valve. This pilot valve allows a fixed outlet pressure to be delivered, for any given inlet pressure, within design constraints. These fixed outlet valves are the most widespread type be found in all countries that implement pressure management. There are many manufacturers, and these valves tend to be very reliable in delivering a lowered pressure profile for a managed water network.

Figure 1

The pressure at the critical point (shown in red), with the fixed outlet PRV set at approx 400 KPa (blue). When the flow into the network (green) exceeds approx 15 l/s the head loss in the network is visible at the critical point.



Hydraulically Flow Modulated Pressure Control
Continued

The downside of the fixed outlet device is that although the pressure is fixed at the valve outlet, due to head loss within a system there will be variations in pressure at other points. For example, a fixed outlet pressure of 30 kPa across a 24 hour period at the PRV site, may deliver a pressure that drops below required standards during peak flow at the 'critical pressure point' within a zone. (The critical pressure point can be defined as the first location within the network that will experience a pressure drop below a specified acceptable. This may be due to elevation, pipe restriction or distance from the inlet). In essence, the pressure at the critical point will vary with customer demand, and so the minimum allowable pressure must be set to maintain statutory pressure levels at the critical point. This may mean that excessive pressure is delivered throughout the rest of the day.

2.2. Modulated Pressure Control

Modulation allows the pressure at a chosen target point (usually the critical pressure point) to be fixed, by compensating for head loss at the outlet of the pressure reducing valve. This means that at all times and flows, the pressure will be maintained at a relatively constant level at the target point. This will lead to fluctuations in pressure at the PRV and other points within the system, but it is not possible to have constant pressure at all points in a dynamic system. This does, however, allow the overall pressure profile to be reduced below that of a fixed outlet valve.

Modulation can be effected using hydraulic or electronic methods. Electronically modulated pressure control comes in a variety of configurations, all of which generally involve complex electronics and some additional costs.

2.2.1. Time Control

A basic form of electronic control can be to make only a couple of adjustments per day to the pressure, such as a day and night profile. This is a simple form of flow modulation, but can have a significant effect in reducing overall pressure profiles. This does not allow the pressure at the target point to be kept constant but can compensate for high and low flow levels.

One of the issues with time controlled pressure management is the inability to react to a high flow requirement during a normal low flow period of the day, for example, a night time fire which requires the fire service to draw large volumes from the network. This is, however, one of the cheapest forms of electronic control.

2.2.2. Electronic Remote Control

The pilot on a pressure reducing valve may be adjusted using a solenoid with inputs from a remote sensing device at the critical or target point. This may be done by telemetry or hard wired sensors that communicate the pressure at the target point back to the valve allowing adjustment to meet a fixed pressure. This is the most exact method of delivering fixed pressure at the target point but also involves investment in infrastructure to communicate between the locations.

Figure 2

The use of local electronic control using a Palmer Control-mate attached to a Cla-Val PRV to deliver a set pressure of approx 22 kPa during night flow conditions and a significant increase in pressure throughout the managed zone during day time demands.

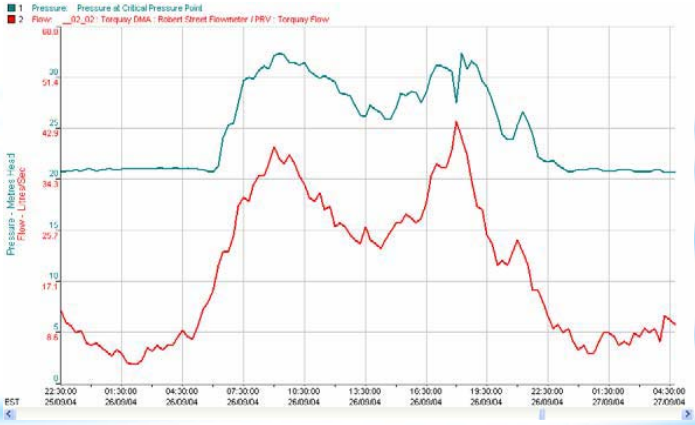
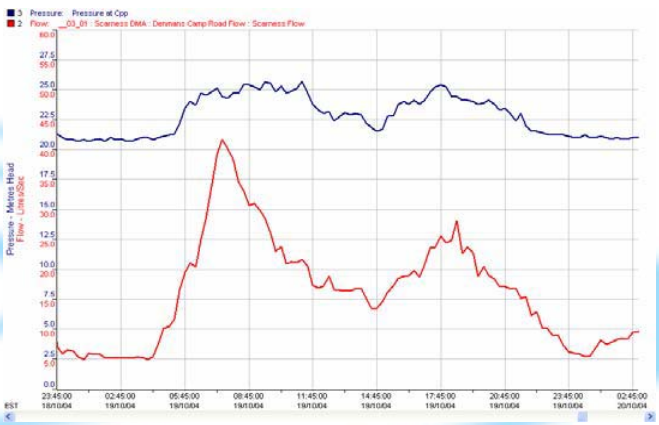


Figure 3

Results from trials using the C-Valves PFR to modulate the pressure at the target point according to flow at the inlet to the zone. The orifice plate could be re-specified to give less variation at the target point if desired.



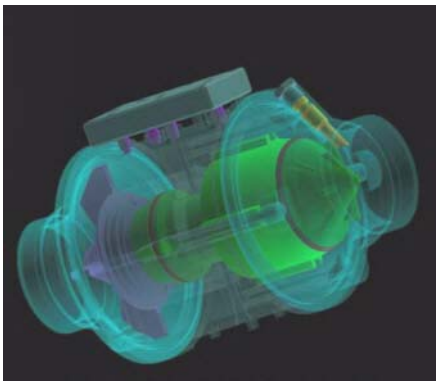
Hydraulically Flow Modulated Pressure Control

Continued

2.2.3. Electronic Local Control

These PRV controllers take a flow measurement from a nearby flow meter and use a pre-programmed relationship between flow and pressure. By setting up the correct relationship in the controller, a fixed pressure can be delivered at the target point. The endearing feature of this style of control is the flexibility to make adjustments to the settings at any time. By adjusting the profile entered into the controller, any desired pressure can be given for any flow rate. This may be used to give a base level of service during low flow times, such as during the night hours, and a more customer friendly level of pressure during higher demand times of the day. Whilst, hydraulic control can give a basic form of this, it cannot be controlled to the same extent.

Transparent view of C-Valves PFR

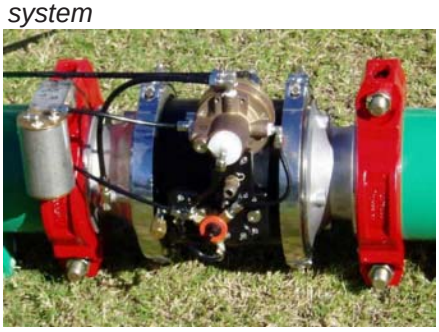


Photograph showing the size of a C-valves M-1 body (right) used to replace an existing PRV.

2.2.4. Hydraulically Flow Modulated Pressure control

Hydraulic flow modulation involves the use of an orifice plate or venturi tube across which head loss is sensed and a constant adjustment of pressure can be made. The pilot is adjusted hydraulically using this head loss. This gives a real-time adjustment of pressure according to the flow sensed at the pressure reducing valve. This doesn't rely on any external input from flow meters or electronic devices. In order for this method to fix the pressure at a target point, there is a need for thorough investigation of the relationship between the pressures at the PRV and the target point. The head loss adjustment can be varied by fitting different sized orifice plates, but this cannot be done without removal of the valve.

Photograph showing the 150mm C-Valves PFR with modular baseplate, 3 way pilot and filter before installation within Wide Bay Water's Hervey Bay water distribution system



3. Hydraulic Flow Modulation Using the C-Valves PFR

3.1. The C-Valves PFR

Wide Bay Water Corporation, as part of their research into innovative demand management products, has been carrying out trials with a relatively new design to the Australian market, distributed by Plasson (Australia). C-Valves, a subsidiary of the large Israeli manufacturer Modgal, have designed a valve that uses "Linear Flow Linear Control" or LFLC technology. This represents a new control concept, which is done linearly and parallel to the flow, as opposed to the more common way, which is perpendicular to the flow. This valve body is called the M-1 and has several unique design features which, from our research and other independently assessed trials, appear to give it some advantages over other valves on the market. The valve is constructed in 316 stainless steel and fibre reinforced nylon 12 making it very light compared with the traditional cast iron valves and giving very good cavitation and corrosion resistance. It is also constructed in a modular way with pilot valves attached via an easily removable baseplate, allowing for quick changes to the configuration or mode

Table 1 - Claimed benefits of the C-Valve M-1

Design Factor	C-Valve M-1	Conventional
Flow Direction	Linear	Perendicular
Pressure Regulation Ratio	Up to 12:1	Up to 4.5:1
Head Loss Across Valve	Kv* = 475	Kv* = 200-300
Opening / Closing Time	2 - 10 seconds	8 to 100 seconds
Closure Type	Soft close - fast then Slow	Surge close - Slow then fast
Normal State	Open or Closed	Open
Weight (100mm PN16)	16Kg	45 - 75 Kg
Body Material	Reinforced Nylon & 316 Stainless Steel	Cast Iron

**Kv = Flow rate in m^3/h at 100kPa pressure drop*

Hydraulically Flow Modulated Pressure Control
Continued

of operation. Due to the 'straight through' design of the body, there is very little head loss when fully open, allowing a smaller valve to be installed when a much larger traditional style PRV would usually be required. In some situations existing 250mm valves have been replaced with 100mm M-1 valves.

The valve being tested is a normally open hydraulically flow modulated PRV or "PFR" (Pressure Flow Regulator). This valve has been designed for use within the water supply industry and differs from the initial C-valve design, which was classed as normally closed. The original normally closed version provides a failsafe shut off for implementations within the mining industry or a water distribution system with very high pressure differential, but will shut off supply to a supplied population on failure, unless a parallel backup valve is installed.

The normally open valve was specially designed for water demand management where reduced pressures are required within a managed zone, but in the event of a valve failure the water supply will be maintained, not shut off. Either version can be specified according to the requirements at each individual demand management area.

3.2. Claimed benefits of the C-Valves M-1 valve body

Modgal group have been distributing the M-1 body in various forms of pressure control device for approximately 10 years throughout the world and have had the product independently tested on several occasions. From these results they have been able to make the following comparisons (See table 1) with other control valves on the market.

Figure 4

Upstream and downstream pressures at the C-Valves PFR set in PRV mode. The pressure variation and spikes are removed by the valve.

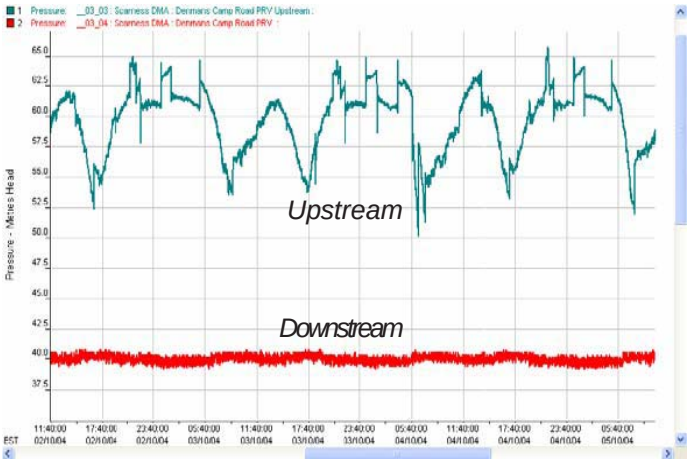


Figure 5

System pressure is insufficient to maintain critical point during times of peak demand. The C-valve is fully open during this time.

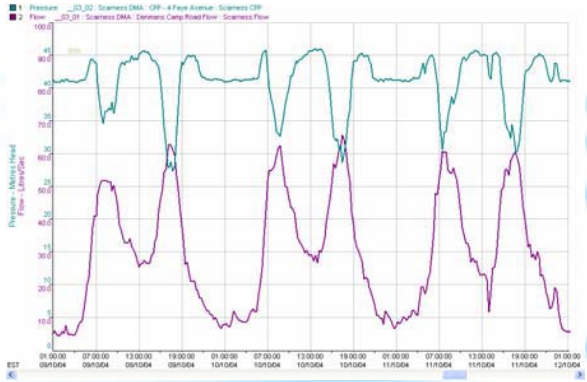
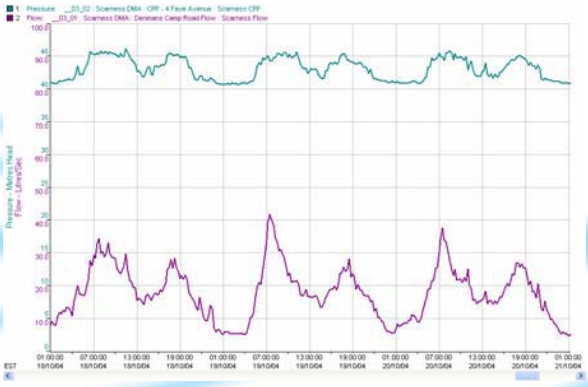


Figure 6

Demand is reduced by 50%. The C-valve increases pressure at critical point during increased demand



Hydraulically Flow Modulated Pressure Control

Continued

3.3. Trial results

The Plasson supplied C-Valves PFR unit is being trialled in an established District Metered Area (DMA) within Wide Bay Water's city network. For initial testing the valve was commissioned with the upstream pressure sensing point shut; this causes the valve to operate as a fixed outlet PRV. Once it had been established that the valve was working correctly the upstream sensing point was opened, enabling the valve to operate in flow modulated pressure control mode.

In order for the valve to have the desired effect on the target point, it is important to provide the manufacturer with network performance data for the full range of flows. This allows supply of the correct sized orifice plate. For the Wide Bay Water trial a number of orifice plates were supplied and the most suitable size was installed.

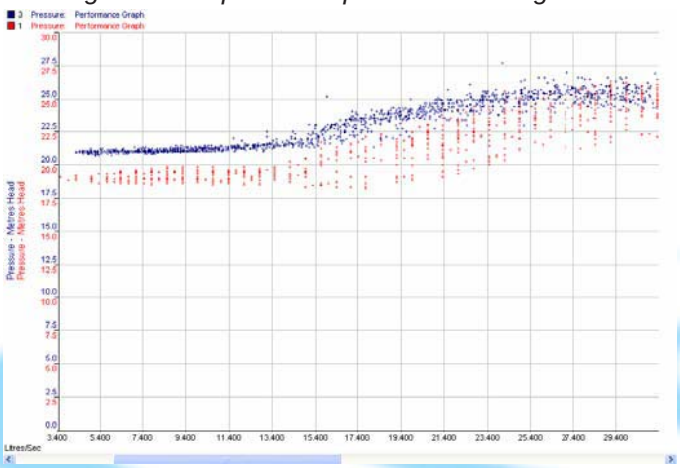
Initial results seem to indicate that the valve was not performing correctly, and wasn't increasing with the flow rate. Further investigation showed that the valve was operating correctly, but the network could not be supplied adequately through the existing single inlet supply. During peak demand the system was unable to deliver adequate supply to maintain pressure at the critical point (see figure 5). This was further proved when several days of rain, cut demand by up to 50%; allowing the DMA to function satisfactorily and showing evidence that the PFR was working effectively in flow modulating mode (see figure 6)

Table 2 - Comparison between Electronic and Hydraulic modulation of pressure

	Electronic	Hydraulic
Pre-design	Minimal (flexible)	Essential
Approx. equipment cost (100mm)	$15k (incl. PRV)	$5k
Flexibility	Fixed, timed or flow modulated	Fixed or flow modulated
Installation	Complex	Simple
Modulation	Totally programmable	Fixed modulation profile
Maintenance	Electrical and hydraulic	Hydraulic only

Figure 7

Figure 7 plots flow against pressure for both hydraulically (C-Valves = blue) and electronically (Palmer control-mate and Cla-val PRV = red) controlled valves. The hydraulic controlled valve shows a narrow spread of plotted readings resulting from the quicker response to a change in flow.



C-Valves, blue, narrow band of plots

Palmer control-mate and Cla-val PRV, red, plots more widely dispersed

4. Hydraulic vs. Electronic Pressure Control

In order to decide whether a district metered area is going to benefit from flow modulated pressure control it is necessary to investigate the pressure profiles within the network. Many networks can gain benefit from basic fixed outlet pressure control, and may not require more complex modulated control. If it is established that flow modulation will give improved results, the choice then needs to be made between Electronic or Hydraulic control. Table 2 gives a comparison between the two methods.

Hydraulically flow modulated pressure control valves are supplied by a number of manufacturers other than C-valves (Plasson), such as Cla-Val (Tyco Flow Control) and Singer (Valveco Industries). Hydraulic flow modulation is far cheaper than electronic control, but does not provide the flexibility of being able to programme the required pressure profile into the controller.

Hydraulically Flow Modulated Pressure Control
Continued

In essence, once a desired pressure profile has been decided this is installed and cannot be changed unless a new orifice plate is supplied and fitted. Seasonal changes in a location may cause water supply requirements within a network to vary several times within a year and this could necessitate a number of changes to the pressure profile and may limit the effectiveness of a less flexible system. If, however, the zone investigation provides accurate stable data there may be no need for this profile to change.

Electronic controllers such as the Palmer Control-mate or the Technolog Autowat are more expensive than basic or hydraulically modulated pressure management but allow full control of the pressure profile within the hydraulic capabilities of the water distribution network.

Hydraulic flow controllers react to changes on a real time basis; any change in flow is immediately detected across the orifice plate and initiates a relative change in the pressure according to the orifice size. Electronic controllers work slightly differently and pressure is managed over an average flow period; for example, the flow may be averaged over a 15 minute period and the pressure set accordingly. This, in effect, smooths the pressure profile but does not react to sudden requirements for change.

4. Conclusions

There are many forms of control valve available to maintain pressure profiles within a water distribution and every manufacturer has a catalogue of models that can produce a multitude of results.

Hydraulically flow modulated pressure control is an economic way to introduce pressure control with additional customer service benefits. The design of units such as the C-valve PFR allow a single device to be used as a simple pressure reducing valve, a flow modulated valve, or if required, by the addition of a controller, can be 'upgraded' to an electronically programmable unit.

The cost of the hydraulically modulated valve is in the same range as a standard pressure reduction valve, so it would seem a viable option to install with the option to retro-fit a controller at a later date if required.

Is hydraulically flow modulated pressure control the way forward? Well, let's say it is definitely a step in the right direction.

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